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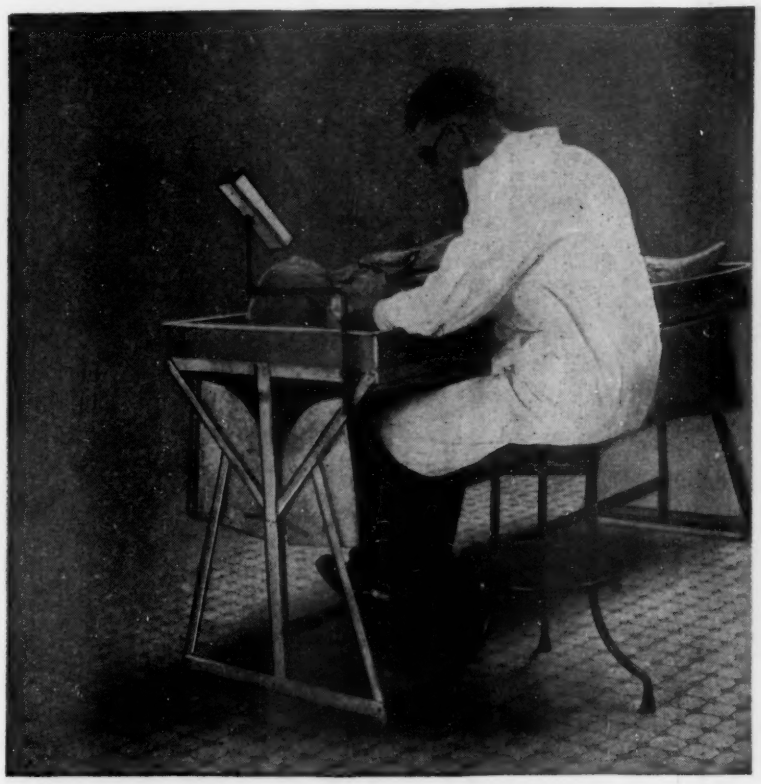

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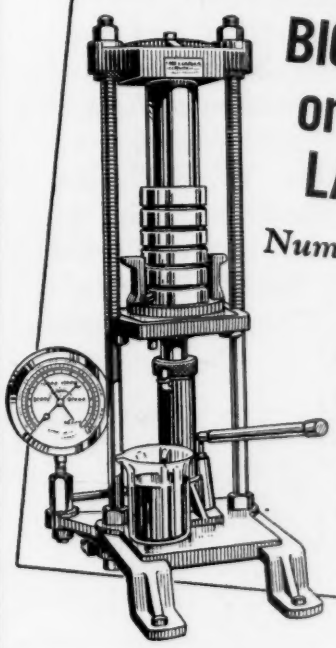

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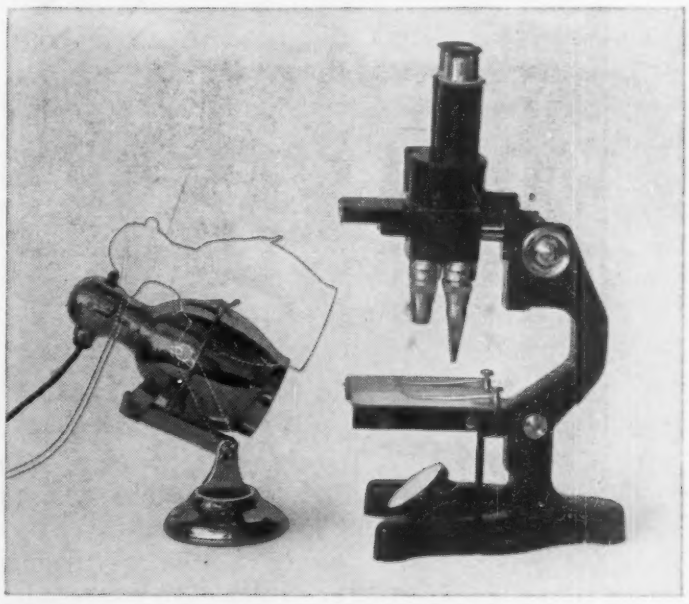

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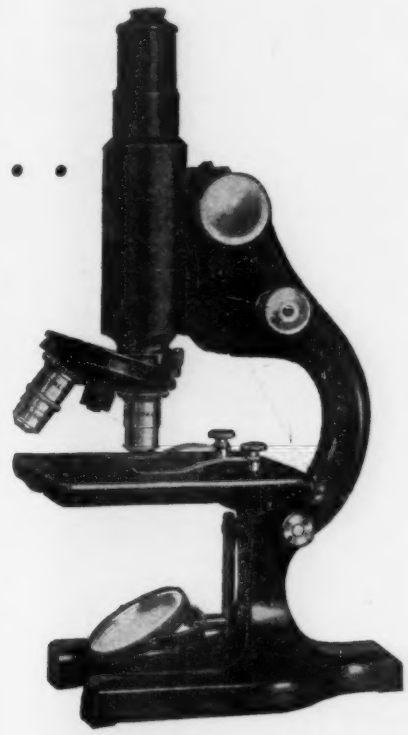

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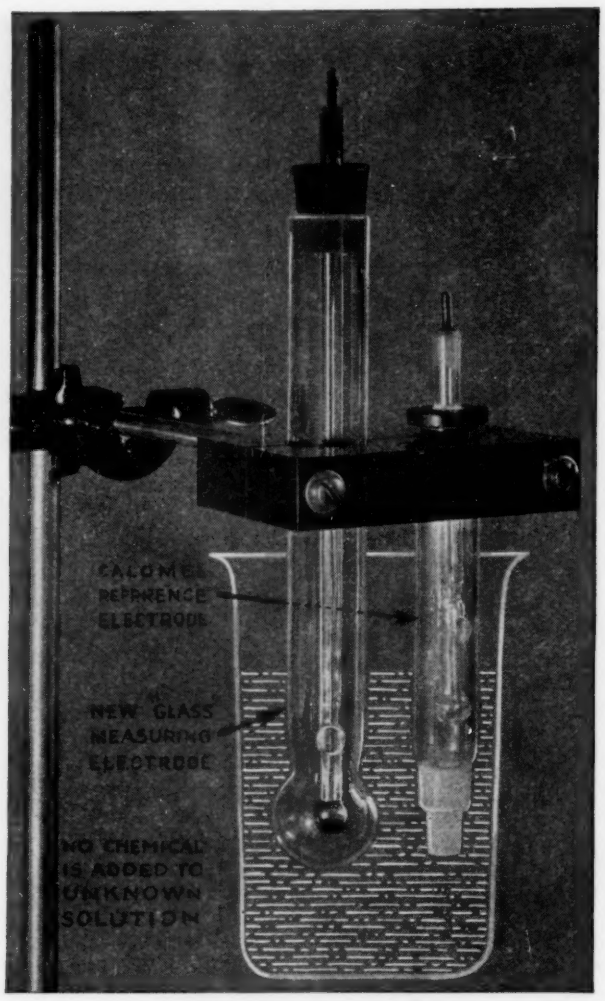

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THE GLACIERS OF MOUNTAIN AND CONTINENT[1]

By Professor WILLIAM HERBERT HOBBS

UNIVERSITY OF MICHIGAN

GLACIERS are found to-day in practically all latitudes, but are found larger and more amply nourished as one recedes from the equator, and also as one approaches those coasts of the continents where moisture-laden winds advance from the sea athwart lofty mountain ranges. Within the torrid zone the glaciers retreat into the higher portions of very lofty mountains. Of altogether exceptional development are the low-latitude glaciers of the Himalayan region in Southern Asia, due to the extreme altitude, in combination with the heavy precipitation brought in by the monsoon winds from the heated Indian Ocean.

All glaciers are fed by moisture in the form of snow, or in some cases of rime, which becomes compacted into ice under its own weight and through recrystallization. They are always of fresh-water ice, in which respect they are in contrast with sea-ice and floe-ice, which are formed by the freezing of the surface layers of the sea. Glaciers, moreover, are land *born,* as they are quite generally land *borne,* though with important exceptions within the high latitudes.

Living in a world of glaciers, it has been natural for us to apply Lyell's phrase, "the present is the key to the past," and to assume that glaciers have been characteristic of all past geological ages as well as of the present; but the evidence from both geology and paleontology is that for the greater part of geological time there have apparently been no glaciers, and the climate from the equator to at least near the poles

[1] Introductory portion of the address of the retiring vice-president of the Section of Geology and Geography, American Association for the Advancement of Science, delivered at Cambridge, Massachusetts, on December 27, 1933. The full paper is to appear in the *Zeitschrift fuer Gletscherkunde.*

has been without marked climatic zones but, uniform, mild and humid, much as is the subtropical climate of to-day. The normal condition of our planet has thus been quite unlike the relatively brief and wholly abnormal glacial period in which we are living.

Of widely extended glaciation we know of but three periods, namely, at or just before the beginning of the Cambrian, in the Permo-Carboniferous and in the Pleistocene-Present. Of the latest of these there have been already four or five separate glaciations, separated by mild interglacial periods. We seem now to be in the receding hemicycle of the latest of these Pleistocene-Present glacial periods; for it is a general rule that the glaciers of to-day are withdrawing their fronts and in other ways making clear that their dimensions are diminishing.

In the development of scientific theories chance has played no insignificant rôle and it was a most unfortunate circumstance that the Pleistocene continental glaciers of North America and Europe should have been studied and their characteristics envisioned before any existing continental glacier had been even seen save from a remote distance. Scheuchzer, De Saussure, Hugi, Venetz and Charpentier, pioneers in the study of Alpine glaciation, had all completed their important researches in the early thirties of the nineteenth century, and Louis Agassiz, the father of the theory of continental glaciation as applied to northern Europe and northern North America, had completed his important studies in the first half of that century. The discovery of the Antarctic continent from the sea was, strangely enough, contemporaneous with the pioneer studies of Venetz, Charpentier and Agassiz, but no landing was made upon the Antarctic glacier until more than another half century had elapsed, and no clear picture of this greatest of existing continental glaciers had been acquired until even later. As regards the other continental glacier, that of Greenland, the first invasions of this area occurred in 1883 (Baron Nordenskiöld), in 1886 (Peary) and in 1888 (Nansen), full forty years or more after the Agassiz conception of Pleistocene continental glaciation had taken form. It is perhaps not strange, therefore, that the model of this conception was the Alpine one, with flow toward the margins from the highest point, with nourishment of the same pattern, and with degradational effects in all essential respects the same. Ideas so imbedded are apt to persist and are not easily uprooted, particularly when actual demonstration in some cases may not be practicable. The result has been that the Pleistocene continental glaciers have been reconstructed from their traces upon the model of the mountain glaciers of the Alps, with which alone the early glacialists were familiar. One of our greatest American students of Pleistocene glaciers was never able fully to appreciate the essential differences between continental and mountain glaciers as respects their modes of nourishment, their internal movements and their reactions with the lithosphere. By him and his students to-day continental and mountain glaciers have been treated as though these vitally important differences were non-existent.

In reality there are to-day three great classes of glaciers which differ rather widely from one another, namely, (1) those of mountains or mountain glaciers, (2) continental glaciers and (3) icecap glaciers, those glaciers in high latitudes which spread over a rock pedestal and may perhaps be regarded as intermediate, connecting the two extreme classes of mountain and continental glaciers. Though distinguished sharply from each other, yet it is possible that many of the icecaps have actually at some time in the past evolved from glaciers of the mountain class, and graded through all intermediate stages to the continental type as a consequence of progressive changes in climate. Thus some of the simpler of mountain types represent the beginnings of glaciation as continental glaciers do its culmination, and as the climatic cycle passes into its receding hemicycle somewhat similar changes succeed to one another, though in the reverse order. Differences of latitude, of altitude and of amount of precipitation are, however, responsible for our discovery of representatives of many of these earlier types to-day during what appears to be a general retrogression of the glacial cycle.

It is pretty clear that, were we living in the advancing hemicycle of glaciation, we should find examples of some types of glacier not now represented, and it would be natural for purposes of discussion to consider the types of glacier in the order in which they made their appearance within the glacial cycle, and later their disappearance. Deficiency in alimentation has within some districts held back the evolution of the glacier and so preserved for us traces of types which belong in the advancing hemicycle even when the glaciers themselves are not in existence to-day. They are in some cases to be reconstructed from the land sculpture they have left behind.

Before proceeding to develop upon this basis the types of mountain glaciers, it would be well to consider the general characteristics of the two contrasted classes of mountain and continental glaciers and the intermediate type of icecaps. The essential differences in the main classes relate to (1) size, (2) figure, (3) mode of nourishment, (4) internal movement and surface processes which make or retain the figure, and (5) sculpture of the terrane beneath and about the glacier. In all these particulars the two main

glacier classes are strikingly contrasted. We shall consider these particulars *seriatim*.

(1) *Size*. The mountain glaciers range in size from those that are hardly more than glorified snowdrifts, a fraction of a mile only in length, to the glaciers of the Pamir and Himalaya Highlands, as yet but partially surveyed, where they in some instances reach extreme dimensions of 100 miles or more. Upon the other hand, continental glaciers of to-day have continental magnitude with extreme dimensions of 1,500 miles (Greenland) and 3,000 miles (Antarctic), with those of the Pleistocene of the same order of magnitude but considerably larger.

(2) *Figure*. As regards the figure of mountain glaciers, despite the wide range represented, this is in most cases determined by the form of the container of rock within which the glacier is included. As in liquid containers generally the walls here rise above the contained material, but the containers are inclined (dished) so that there is always a higher and an opposed lower side. On the lower side the container wall is generally lacking, but the concentrated wastage of the glacier toward that margin makes the containing wall unnecessary.

A few glaciers inherit a container, such, for example, as the crater of a volcano, and these comprise a separate group of a few types only. Together they may be referred to as the class of *inherited basin glaciers*. By contrast with the mountain glaciers the continental glaciers are not contained, but spread broadly over vast areas uncontrolled by the terrane and assume figures determined by their own properties. This figure is a greatly flattened dome which bears closest resemblance to a round watch crystal or watch cover of the traditional variety.

(3) *Mode of Nourishment*. All mountain glaciers of whatever type owe their origin and continued nourishment to accumulated snow, which is derived from *ascending* moisture-laden air currents. Through large adiabatic refrigeration these air currents are forced to deposit their moisture content in the higher mountain levels as snow. In strongest contrast continental glaciers receive their contribution of snow (and rime) from *descending* air currents within an overlying glacial anticyclone, where adiabatic elevation of temperature is a consequence, and the precipitation is apparently the immediate result of abstraction of heat by the cold surface of the glacier from near-surface air layers. The centrifugal (and downward) direction of the surface winds over the glacier quite precludes the possibility of nourishment by ascending air currents, as is the case with mountain glaciers.

(4) *Internal Movement and Surface Changes which Make and Retain the Figure*. Since the pioneer studies upon mountain glaciers, it has been recognized that these glaciers are nourished chiefly in their higher levels, from which the ice has a gravitational downward movement toward their lowest levels, where wastage by melting is concentrated. Mountain glaciers have thus an internal movement downward throughout and are differentiated into an upper region of alimentation and a lower region of wastage. Their figure is in part determined by this differentiation, and as climate becomes more genial the glacier alimentation decreases as the wastage increases, and the front of the glacier retires until its last stand against extinction is made along the wall at its head. This law, on which the intermediate glacier types are based, depends upon the prevalence of above-freezing, and therefore wasting, air temperatures within the lower levels of the atmosphere. Within the Antarctic region, however, where above-freezing temperatures are not experienced even in midsummer, save within highly localized areas and for brief periods only, the law does not hold, and so there are new and special Antarctic glacier types.

As already pointed out, the Pleistocene continental glaciers were the first to be studied and reconstructed from their now abandoned beds upon the model of the mountain glaciers of the Alps. To-day we are able to say that internal movement goes on along the steep front of continental glaciers and as far back from the front as their appreciable slopes extend. This seems to be proven by the crevassed surface, always a consequence of differential internal ice movements. That back of this marginal zone there is internal movement of the ice there is no evidence whatever. The prevalent misconception is an inheritance from the picture formed of Pleistocene continental glaciers before existing continental glaciers had been observed. The glaciated rock surface overridden by the continental glaciers, bears a record of the erosional work beneath the *marginal zone only*, which both during the advance and the retreat of the ice-front has moved in turn over all parts of the entire glaciated area. It thus supplies no warrant whatever for supposing that such action has gone on beneath the vast central area.

The distribution of the fine snow that falls over the continental glacier from descending and centrifugally directed surface currents, is redistributed by these currents and so is carried outward toward their margins in quantities measured literally by the millions of tons. It is this gigantic centrifugal snow-broom which appears to have contributed to give shape to the watch-like figure of existing, and presumably of all, continental glaciers.

(5) *Sculpture of the Rock beneath and about the*

Glacier. It is a consequence of the fact that mountain glaciers are in all cases essentially streams of ice which pursue definite courses, whereas continental glaciers spread broadly over all the country; that the former have excavated steep-walled trenches and vast amphitheaters to produce the most rugged topography that is anywhere known; while continental glaciers by sharpest contrast have employed the erosional processes only to pare down elevations and fill in depressions, so as to "iron out" the existing features and reduce the accent of the relief. Eventually they produce a broadly undulating surface from which all earlier characters have been effaced.

Résumé. Mountain glaciers are of moderate proportions, are held within rock containers, are nourished by ascending air currents, have internal movement throughout and transform the topography into the most rugged type that is known. Continental glaciers are of vast proportions, are not contained but take on always a flatly domed surface, are nourished by descending air currents within a glacial anticyclone, have their internal gravitational movement apparently restricted to the marginal zone, and produce some of the most monotonous flatly undulating topography that is known.

The icecaps of high latitudes occupy a position intermediate between the mountain and continental glacier classes, and they doubtless represent an intermediate stage through which the continental glacier in some cases at least has evolved from earlier mountain glaciers. In size the icecaps are intermediate, but nearer the mountain glacier. In form they differ little from the continental glacier, save only that the dome is much less flat. They rest upon rock pedestals and in all cases are of depth sufficient to fill and overwhelm all the inequalities of their rock floor. As regards their mode of nourishment also, icecaps seem to occupy an intermediate position. The smaller ones are in part at least nourished by ascending currents after the manner of mountain glaciers, whereas the larger ones are able to develop a local centrifugal surface-air circulation for at least much of the time. The largest of all, that of Northeast Land in Svalbard, has been shown to possess a glacial anticyclone which, however, for short periods—during the passage of a strong cyclone—loses its domination, only to snap back into position so soon as the depression has passed on. In respect to shaping the rock beneath, icecaps are more allied to the continental glacier, with its restriction to the employment of plucking and abrasion only. Along their borders icecaps and continental glaciers alike send out tentacles of ice which possess many of the properties of the true mountain glaciers, and those of the icecaps particularly have often a scalloped margin due to a series of amphitheatral basins upon their borders.

OBITUARY

ROBERT HENRY WOLCOTT

AFTER a long and fruitful career, prominently in connection with the University of Nebraska, Professor Robert Henry Wolcott died on January 23, of carcinoma of the liver. Previously in robust health, he had been ill for only a few months before his death. At that time he was chairman of the department of zoology in the University of Nebraska and acting chairman of the department of bacteriology and pathology.

Dr. Wolcott was born at Alton, Illinois, on October 11, 1868. He spent most of his early life in Grand Rapids, where his father was prominently associated with the furniture industry. He was early brought into contact with a group of naturalists and acquired a love for outdoor studies which played a prominent part in his later life. He went to Michigan for his college work and was naturally drawn into the biological field. He was given the B.L. degree in 1890 and the B.S. in 1892 but during this time he was also concerned with studies in medicine. In 1893 he was granted the degree of M.D. but never engaged in active practise. His interest was in the scientific aspects of the biological field and he embraced an opportunity offered to participate in the biological survey of Michigan waters then under way with especial reference to the features involved in the maintenance and increase of the fish supply. He served as a member of the party of biologists working at New Baltimore in the summer of 1893 and at Charlevoix in 1894. It was as a member of the first party under the leadership of Professor Jacob Reighard and as director of the survey the following summer that I became familiar with Wolcott's ability as a field naturalist and his desire to follow his interest in that field through teaching and study. Consequently when a vacancy opened in the department of zoology at Nebraska in 1894 I offered him the place. From that time for forty years he served the university and the state with enthusiasm and success in a variety of different positions.

The first year he was an assistant and at its close received the degree of M.A. and an appointment to an instructorship. In 1898 he was made an adjunct professor and in 1902 associate professor of zoology in charge of the work in anatomy. Nineteen hundred and five brought him the professorship in anatomy. With a change in the personnel of the department

in 1909 he became its head and was at the same time made acting dean of the College of Medicine, a position that he held until 1914. Up to that date two years of the work of the College of Medicine had been given in Lincoln and the clinical years in Omaha. When the growth and development of the college rendered the transfer of all the work to Omaha advisable, he elected to remain at Lincoln, continuing as head of the department of zoology and dean of the Junior Medical College there.

He served several years as a member of the summer faculty at the University of Minnesota and later for a number of seasons as a member of the staff of the Puget Sound Biological Station.

Dr. Wolcott was throughout his life an enthusiastic field naturalist. Year after year he followed the migrations of the birds with great exactitude. Winter and summer he roamed about the fields in the vicinity, taking voluminous notes on the conditions he observed. These items were constantly introduced into his lectures and discussions with students, who found in the rich fund of information regarding nature and life a stimulus to their own interest and activity in college courses and outdoor studies. He rarely went alone and always was a genial and inspiring companion on these excursions.

His early publications on the water mites gave Wolcott the position of final authority on this group, a rank widely recognized by workers here and abroad. His book on the birds of Nebraska, in the preparation of which he had the assistance of Professors Bruner and Swenk, was a most careful record as well as one of the earliest studies of the local avifauna in a region which lies in the center of the migration route of a large and varied bird population. His latest book, a text on animal biology for beginning college classes, was published in the summer of 1932. He wrote numerous articles on a variety of special topics in zoology and related fields as distant as soil conservation. These, coupled with his friendly personality and wide contacts, especially in the state, made him a significant factor in the development of biology in the university and the extension of its influence throughout Nebraska.

Scientific societies were to Dr. Wolcott deserving of active attention. He was secretary and editor of the American Microscopical Society from 1904 to 1908; president of the Nebraska Academy of Science; active in founding the Nebraska Ornithologists Union, which he later served as president for several years, and a constant worker in numerous other organizations, especially in ecology and ornithology. He was a fellow of the American Association for the Advancement of Science and also a member of Sigma Xi.

In 1897 Dr. Wolcott was married to Miss Clara Buckstaff, of Lincoln, who with a daughter, Mrs. Gerald Carpender, and a son, Allen, both of Lincoln, and a brother Samuel of Minneapolis survive him.

HENRY B. WARD

SCIENTIFIC EVENTS

INDUSTRY AND THE RESEARCH ASSOCIATIONS OF GREAT BRITAIN[1]

ON March 22, the Department of Scientific and Industrial Research convened an important conference at the Institution of Civil Engineers, at which Lord Rutherford presided, and more than one hundred representatives of the twenty-one research associations formed under the auspices of the department were present. The object was to provide an opportunity for frank discussion with officers of the department and members of its Advisory Council on the present position of the research association movement and its future.

On the eve of the conference, Sir Kenneth Lee, who is a member of the Advisory Council closely identified with the work of the research associations, and whose firm belief in industrial research is well known, entertained the representatives at dinner. Mr. Runciman represented the government, and many prominent men in industry, finance and in the Civil Service were present. Among the speakers were Mr. Runciman, Lord Rutherford and the Right Hon. Reginald McKenna. In the course of his remarks, Mr. Runciman read a statement from the Lord President of the Council, in which Mr. Baldwin said that those present no doubt shared the opinion of the Advisory Council that the present scale of operations of the research associations is totally inadequate if they are to serve their full purpose. He looked forward, with confidence, to industrialists improving matters in that respect, especially now that the prospects of trade are more promising. If they do so, Mr. Baldwin's message continued, they can rely on the government on its side being prepared to play some part in the forward movement and to help in extending the scale of operations.

The views expressed at the conference left no doubt that the Advisory Council of the Department is right in believing that the time is ripe for a great development in the research association movement. The associations have already made a deep impression on British industry, not only in producing practical results of great monetary value, but also in bringing

[1] *Nature.*

about a more sympathetic attitude towards the usefulness of scientifically trained men in the works. Several speakers emphasized the paramount duty of research associations of carrying out long-range investigations essential to widening the boundaries of knowledge. Reference was made to the benefits conferred on the consumer by the improvement in products as regards utility and price and to the raising of the standard of living resulting therefrom, and for this reason it was urged that a continuation of a substantial contribution from government sources is fully justified. Attention was also directed to the importance of achieving stability of finance for the research associations as a means of securing the best work from those employed by them, or ensuring that the best scientific brains are available for that purpose and of making possible the planning of long-distance programs.

At the conclusion of the proceedings, Lord Rutherford referred to the statement made by Mr. Runciman the previous night on behalf of the Lord President as to the willingness of the government to afford increased financial help, and urged that as a next step the councils of the research associations should consider the scale of work required to meet the needs of their particular industries and submit proposals for the consideration of the department, in order to bring about at the earliest possible date a very different scale of operations.

THE NEW WEATHER FORECAST PROGRAM

ACCORDING to an announcement made by W. R. Gregg, chief of the Weather Bureau, with the cooperation of the War, Navy and Commerce Departments, the Weather Bureau of the U. S. Department of Agriculture, on July 1, 1934, will initiate part of its new program for increasing the accuracy of its forecasts. This new program calls for more stations for upper air soundings by airplanes and for more frequent daily forecasts. The part covering more airplane observations can now be put into effect.

The air-mass method of forecasting, long recognized as an aid to accuracy and to longer forecasts, has not hitherto been practicable because of the difficulty of getting the needed upper-air observations. Facilities offered by Army and Navy pilots at more than a dozen selected stations, at six specially-equipped Weather Bureau airway stations, and at one cooperative station at the Massachusetts Institute of Technology, now remove this difficulty. The Department of Commerce will provide for the transmission of the observations from the points where they are taken to the forecasting stations.

According to the present plan, Mr. Gregg says, observation flights will be confined to one a day, each beginning about half past five (E.S.T.) in the morning and reaching a maximum height of 17,000 feet above sea level. These flights will be made by Army and Navy pilots and by commercial aviators employed for the purpose by the Weather Bureau. Meteorologists of the Weather Bureau assigned to the air-observation stations will compute, code and transmit to forecast stations the information brought down by the meteorographs. Forecasters will thus be supplied with an important supplement to the morning surface observations in drawing the weather maps to be used in making the daily forecasts.

The Weather Bureau expects to maintain special airplane observation stations at the following airports: Nashville, Tenn., with La Crosse, Wis., as an alternate; Omaha, Neb., Cheyenne, Wyo.; Billings, Mont.; Fargo, N. Dak., and Oklahoma City, Okla.

The War Department will assign planes for this work at Mitchell Field, Long Island, N. Y.; Selfridge Field, Detroit, Mich.; Wright Field, Dayton, O.; Scott Field, East St. Louis, Ill.; Kelly Field, San Antonio, Tex.; Maxwell Field, Montgomery, Ala.; and, during the hurricane season, at Fort Crockett, Galveston, Tex. The National Guard unit at Spokane, Wash., has assumed the responsibility for collecting the needed information there.

The Navy Department will make the observations at the following stations: Anacostia, D. C.; Norfolk, Va.; Pensacola, Fla.; San Diego, Calif.; Pearl Harbor, Hawaii; and, on alternate days, at Philadelphia, Pa., and Lakehurst, N. J. Observation flights at Sunnyvale, Calif., and Seattle, Wash., because of darkness at the hour set for the flights, will be made at some daylight hour. Occasional flights may be made also from Quantico, Va., Dahlgren, Va., and Coco Solo, C. Z.

Certain battleships, when in port and sometimes at sea, send up planes to observe weather conditions. Although they are not expected to order routine flights, the following ships will contribute information useful to Weather Bureau forecasters at San Francisco, Calif., or at Washington, D. C., depending on the fleet's location: *Saratoga, Lexington, Langley, Ranger, Wright, California* and *Chicago.*

REPORT OF THE DIRECTOR OF THE FIELD MUSEUM

THE annual report of the director of Field Museum of Natural History to the Board of Trustees has been issued. How the museum is continuing to withstand the effects of the long-continued depression on its financial resources is described by Director Stephen C. Simms, in part as follows:

Like the preceding year, 1933 was marked by severely adverse financial conditions, which caused a further decline in the value of securities held in Field Museum's

endowment funds, as well as a reduction in income from endowments, contributions and memberships.

The budget adopted was very much reduced, and economies were put in force throughout the year, with the result that expenses were kept well below the appropriations, in spite of increased expense incurred through the necessity of handling record attendance during a period of several months. There were no expeditions except those financed by funds especially contributed for that purpose.

Notwithstanding forced economies, service to the public was maintained in full, and never before have so many persons been reached by the educational influences of this institution.

Visitors to the museum during the year numbered 3,269,390, an attendance exceeding that ever attained in a single year by any museum in the United States, and probably a high record for the entire world. The increase over 1932 attendance is 1,455,188, or 79 per cent. Extra-mural activities conducted by the museum benefited approximately 661,000 persons, mostly children, making a total of more than 3,930,000 for whom the institution functioned as a source of information. Of the 3,269,390 visitors to the museum, only 212,298, or 6½ per cent., paid admission. All the rest, numbering 3,057,092, either came on free days, or belonged to classifications such as children, teachers, students and museum members, who are granted free admissions on pay days. The highest attendance for any single day occurred on August 24, when there were 65,966 visitors.

Lecturers from the museum, sent to the schools by the James Nelson and Anna Louise Raymond Foundation for Public School and Children's Lectures, spoke before 160,750 children in their classrooms and assemblies, the talks being illustrated with stereopticon slides. Daily, throughout the school year, approximately 500,000 children had available for study in their schools (and also in various community centers and other institutions) the traveling natural history exhibits circulated by the N. W. Harris Public School Extension of Field Museum.

Mr. Simms reports a decrease in contributions compared with the benefactions received in recent years. The total of such gifts was $47,320, received in various amounts to be devoted to specific uses.

The book contains detailed accounts of the installation of new exhibits, most important of which were the two new halls—Chauncey Keep Memorial Hall, containing the races of mankind bronzes by the sculptor Malvina Hoffman, and the Hall of the Stone Age of the Old World, containing group restorations of various types of prehistoric man. Other activities reported upon include the research and field work conducted by the four scientific departments—anthropology, botany, geology and zoology; accessions of exhibition and study material received from various sources; the year's progress in the museum library, and the work of all other divisions of the museum organization.

CHARTER MEMBERS OF THE AMERICAN ACADEMY OF TROPICAL MEDICINE

THE following have been elected to charter-membership in The American Academy of Tropical Medicine by the Council of the Academy, in accordance with instructions given the council at the recent Conference on Tropical Diseases held in Washington, D. C., on February 5 and 6, under the auspices of the National Research Council:

Bailey K. Ashford, Geo. W. Bachman, M. A. Barber, Chas. C. Bass, M. F. Boyd, Chas. S. Butler, Geo. R. Callender, Roland C. Connor, Carroll E. Faust, Frederick P. Gay, Lewis W. Hackett, Maurice C. Hall, Henry Hanson, Robt. Hegner, Victor G. Heiser, Wm. M. James, Jas. W. Jobling, Chas. A. Kofoid, Robt. A. Lambert, Thos. T. Mackie, Wm. G. MacCallum, George W. McCoy, Karl F. Meyer, Frederick G. Novy, F. W. O'Connor, F. M. Root, Frederick F. Russell, Wilbur A. Sawyer, A. W. Sellards, Geo. C. Shattuck, Joseph F. Siler, M. H. Soule, C. W. Stiles, E. R. Stitt, James S. Simmons, Wm. H. Taliaferro, E. E. Tyzzer, Edward B. Vedder, Henry B. Ward, E. L. Walker, H. Windsor Wade.

These with the officers of the academy constitute the total number of fifty charter members authorized by the conference. The officers elected at Washington are:

President, Theobald Smith, Rockefeller Institute, Princeton, N. J.

Vice-president, Chas. F. Craig, Tulane University.

Secretary, Earl B. McKinley, George Washington University.

Treasurer, W. W. Cort, the Johns Hopkins University.

Members of the Council, Stanhope Bayne-Jones, Herbert C. Clark, Richard P. Strong, Alfred C. Reed, Henry E. Meleney.

GRANTS-IN-AID OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES

AT the April meeting of the American Academy of Arts and Sciences announcement was made of grants-in-aid from the permanent science fund of the academy, as follows:

To Dr. Joseph C. Boyce, of the Massachusetts Institute of Technology, for aid in investigating the extreme ultra-violet spark spectra of krypton and xenon.

To Dr. T. T. Chen, of the University of Pennsylvania, $90 to aid in the preparation of a monograph on the cytology of Opalinid Ciliate Protozoa.

To Dr. W. W. Coblentz, of the U. S. Bureau of Standards, $400 for use in connection with an evaluation of ultra-violet in sunlight at Flagstaff, Arizona.

To Professor E. A. Culler, of the University of Illinois, $350 for aid in an investigation of the effect upon hearing of protracted exposure to sound frequencies of high intensity.

To Professor James William McBain, of Stanford University, $400 for aid in determining adsorption in the air-water interface.

To Professor Charles Palache, of Harvard University, $250 for assistance in a study of the chemical composition of the mineral, samarskite, especially with respect to its content of uranium, thorium and lead as a basis for the determination of geological age.

To Professor Gayle Scott, of Texas Christian University, $500 for expenses in connection with a study of the stratigraphy and paleontology of the Trinity group in Texas.

To Professor A. Franklin Shull, of the University of Michigan, $500 for use in connection with an investigation of the internal and external factors which influence wing production in aphids.

The American Academy of Arts and Sciences ordinarily makes grants from the Permanent Science Fund twice each year. The next meeting of the committee will be held on October 2, and applications for grants should be in its hands before September 10. These should be addressed to Professor E. M. East, Chairman of the Committee on the Permanent Science Fund, American Academy of Arts and Sciences, 28 Newbury Street, Boston, Massachusetts.

SCIENTIFIC NOTES AND NEWS

A DINNER in honor of Dr. Karl Pearson, to commemorate his retirement from the professorship of eugenics at the University of London, which he has held for forty-nine years, was given at University College on April 23. The Vice-Chancellor, Professor L. N. G. Filon, presided, and presented Professor Pearson with a bronze portrait plaque "in grateful commemoration of his research, teaching and inspiration," with a book containing the signatures of 267 subscribers, a Brunsviga calculating machine and a check for £440. In addition to Professor Filon, the speakers included Professor Harald Westergaard, G. Udny Yule and Professor M. Greenwood.

DR. GASTON LEON RAMON, chief of the veterinary service of the Pasteur Institute at Garches, has been appointed director of the institute at Paris in succession to the late Dr. Emile Roux.

THE honorary doctorate of the faculty of mathematics and natural science has been conferred by the University of Göttingen on Dr. Kôtarô Honda, professor of physics at Sendai, Japan.

THE honorary degree of doctor of engineering will be conferred by the Michigan College of Mining and Technology at commencement in June on Professor James Fisher, head of the department of mathematics and physics, in recognition of his many years of distinguished service in the field of engineering. Professor Fisher will deliver the commencement address.

HONORARY memberships in the Columbia University Engineering Schools Alumni Association were conferred upon Professor Thomas Henry Harrington, for forty years a member of the faculty of engineering, and on Dr. Daniel Edward Moran, consulting engineer, New York City, at the annual dinner of the association on April 28. Dr. Moran was honored on the occasion of his seventieth birthday and the fiftieth anniversary of his graduation from Columbia. President Nicholas Murray Butler and President Karl T. Compton, of the Massachusetts Institute of Technology, were the principal speakers. A portrait of Professor Harrington, by Michael De Santis, was presented to the university.

PROFESSOR ERNEST MERRITT will retire from administrative work as head of the department of physics at Cornell University at the close of the present academic year. Professor R. C. Gibbs has been appointed chairman for the year 1934–35.

PROFESSOR W. A. SETCHELL, chairman of the department of botany of the University of California, and Dr. N. L. Gardner, associate professor of botany and curator of the herbarium, who joined the university in 1900 as assistant in botany, will retire at the end of the academic year. Dr. Setchell has been a member of the faculty for thirty-nine years.

DR. OSCAR M. SCHLOSS has resigned as professor of pediatrics at the Cornell University Medical School and as pediatrician-in-chief of New York Hospital, to resume private practise. He is to remain with the medical school as professor of clinical pediatrics and with the hospital as attending pediatrician. He also will continue his research work at the hospital. Dr. Samuel Z. Levine, now associate professor and attending pediatrician, has been appointed acting pediatrician-in-chief and acting professor of pediatrics.

DR. HARRY S. VANDIVER, associate professor of mathematics at the University of Texas, has been appointed a temporary lecturer at the Institute for Advanced Study at Princeton, while on leave from the university.

AT its twenty-first annual meeting held in New York City under the auspices of Columbia University from March 28 to 31, the American Society for Experimental Pathology elected the following officers for the year 1934–35: *President,* Dr. S. Burt Wolbach, Shattuck professor of pathological anatomy, Harvard Medical School; *Vice-president,* Dr. Oskar Klotz, pro-

fessor of pathology, University of Toronto; *Secretary-Treasurer,* Dr. Shields Warren, pathologist to the New England Deaconess Hospital and instructor in pathology, Harvard Medical School; *Councilor,* Dr. C. Phillip Miller, associate professor of medicine, University of Chicago; *Representative on the National Research Council,* Dr. Carl V. Weller, professor of pathology and director of Pathological Laboratories, University of Michigan.

FOLLOWING authorization by the council of the Society for Experimental Biology and Medicine, the Southern California Section was organized on April 24 at Los Angeles. Twenty-five members are included. Officers elected were: *Chairman,* Dr. John F. Kessel, professor of bacteriology and parasitology of the School of Medicine of the University of Southern California; *Vice-chairman,* Dr. M. T. Burrows, director of the cancer clinic of the Pasadena Hospital; *Secretary,* Dr. T. D. Beckwith, associate professor of bacteriology at the University of California at Los Angeles.

AT the annual meeting of the Boston Society of Natural History, held on May 2, the following officers were elected for 1934–1935: *President,* Charles H. Taylor; *Vice-presidents,* Nathaniel T. Kidder, Glover M. Allen, William M. Wheeler; *Secretary,* Clinton V. MacCoy; *Treasurer,* Augustus P. Loring, Jr.; *Trustees,* Thomas Barbour, John A. Blanchard, William L. W. Field, Ralph Hornblower, Frederic H. Kennard, John C. Phillips. At the same meeting the annual Walker Prize in Natural History, offered this year for the best memoir on any subject in the field of ornithology, was awarded to Vero Copner Wynne-Edwards, of McGill University, Montreal, for his paper "On the Habits and Distribution of Birds on the North Atlantic."

THE Joseph A. Capps Prize of $500 of the Institute of Medicine of Chicago, given annually for the most meritorious investigation in medicine or the specialties of medicine completed within two years after graduation by a graduate of a Chicago medical school, has been awarded for 1933 to Dr. Gene H. Kistler, of Rush Medical College, 1931, for his paper on "Sequences of Experimental Infarction of the Femur in Rabbits."

THE Porter fellowship in physiology has been awarded by the council of the American Physiological Society to E. H. Kemp. He expects to work at Clark University next year.

WILLIAM B. MARSHALL, assistant curator of mollusks in the United States National Museum, retired from government service on April 30, at his own request, after serving for more than thirty-two years. Mr. Marshall has been given an honorary appointment, under the Smithsonian Institution, as associate in zoology at the U. S. National Museum.

DR. M. M. HOOVER, associate professor of agronomy at West Virginia University, has resigned to become regional director of the Soil Erosion Service at Spencer, W. Va.

J. C. SCHAENZER, who has been project director of rural electrification at the University of Wisconsin, was recently appointed agricultural engineer with the Federal Power Commission. He is stationed at Washington, D. C., and has charge of a national survey of all present rural electrification, including power used for irrigation projects, with a view to outlining future possibilities.

CLYDE E. WILLIAMS has been appointed director of the Battelle Memorial Institute, Columbus, Ohio, and Dr. H. W. Gillett, chief technical adviser. Both Dr. Gillett and Mr. Williams have been associated with the institute since 1929, Dr. Gillett as director. Dr. Gillett will now devote his entire time to the scientific side of the work.

PROFESSOR WITHROW MORSE, who has spent the past two years in research at the New York State Psychiatric Institute of the Columbia Medical Center, has joined the staff of Lederle Laboratories, Inc., and will be associated with Dr. Guy W. Clark at Pearl River, N. Y.

FROM a statement recently given in SCIENCE, it would appear that the neurological unit of which Dr. Tracy Jackson Putnam has been placed in charge, was at the Massachusetts General Hospital. Dr. Putnam is at present assistant professor of neurological surgery at the Massachusetts General Hospital, but as professor of neurology at the Harvard Medical School, he will be in charge of the Neurological Unit at the Boston City Hospital.

SIR ARTHUR STANLEY EDDINGTON, Plumian professor of astronomy at the University of Cambridge, who gave the 1934 Messenger Lectures at Cornell University, sailed for Liverpool on May 6.

DR. ALEXANDER SILVERMAN, head of the department of chemistry at the University of Pittsburgh, who has been visiting Paris, arrived in New York on April 20.

THE Edgar Fahs Smith memorial lecture of the University of Pennsylvania will be given by Dr. Hugh S. Taylor, professor of chemistry at Princeton University, on May 23. Dr. Taylor will speak on "Water in Old Chemistries and New."

PROFESSOR G. H. PARKER, director of the Harvard Zoological Laboratories, delivered the annual address before the Virginia Chapter of the Sigma Xi on April 25, on "The Transmission of Neurohumors."

THE Charles E. Dohme memorial lectures for the

year 1934 were given by Dr. Donald D. Van Slyke, of the Rockefeller Institute for Medical Research, at the Johns Hopkins Medical School on April 26, 27 and 28. The titles of the lectures were "Physiology of the Amino Acids" and "Factors Controlling Urea Excretion."

DR. CHARLES R. STOCKARD, head of the department of anatomy at Cornell University Medical College, delivered on May 2 the principal address at the fifteenth annual banquet of the Beta Lambda Sigma Chapter of New York University. He spoke on "The Rôle of Internal Secretions and Inheritance in the Problem of Body Growth and Form."

DR. DEAN D. LEWIS, professor of surgery at the Johns Hopkins University and president of the American Medical Association, delivered the April lecture on the Smith-Reed-Russell series at the School of Medicine, George Washington University, on April 24, his subject being: "The Hypophysis and Its Relation to Other Glands."

DR. GEORGE B. CRESSEY, chairman of the department of geology and geography at Syracuse University, delivered the Schiff lecture at Cornell University on April 30 on "The Geographical Regions of China and their Inhabitants." In the afternoon he spoke before a geological seminar on "The Distribution and Source of Chinese Loess."

THE annual luncheon meeting of the National Parks Association will be held at the Cosmos Club, Washington, D. C., on May 14. Dr. Cloyd Heck Marvin, president of the George Washington University and president of the association, will preside. Speeches at the luncheon have been arranged as follows: "National Parks as Factors Contributing to National Ideals," Dr. John Huston Finley, editor of *The New York Times;* "New Responsibilities," Arno B. Cammerer, director of the National Park Service; "The Primitive," Dr. John C. Merriam, president of the Carnegie Institution of Washington; "The Reorganization of the National Park Service with Special Emphasis upon the Place of the National Parks in that Scheme," Albert Atwood, writer for the *Saturday Evening Post;* "The Everglades and Ouachita," Robert Sterling Yard, editor of the National Parks Association Publications, and "Future National Park Sites," Dr. Henry B. Ward, permanent secretary of the American Association for the Advancement of Science. The luncheon will be followed after an intermission by the annual meeting of the association.

RECENT speakers before the department of geology and geography at Northwestern University have included: Dr. Joe W. Peoples on "The Geology of the Anthracite Districts, Pennsylvania"; Dr. G. F. Loughlin, geologist in charge of Metals Section, U. S. Geological Survey, on "Recent Developments at Cripple Creek"; Dr. Thos. L. Gledhill, consulting geologist, on "The Gold Belt of Ontario"; Professor Alfred S. Romer, of the University of Chicago, on "Fossil Collecting in the Karoo Desert"; Professor Carey Croneis, of the University of Chicago, on "Micropaleontology"; Dr. Gilbert H. Cady, senior geologist of the Illinois Geological Survey, on "Fundamental Research on Coal"; Dr. M. M. Leighton, chief of the Illinois Geological Survey, on "The Industrial Significance of the State Geological Survey," and Professor D. Jerome Fisher, of the University of Chicago, on "The Origin of Petroleum."

THE pressing of a gold telegraph key, connected by direct wire to the Crosley Transmitter Plant at Mason, O., by President Roosevelt on May 2 inaugurated a six-hour program dedicating WLW, the new 500,000-watt transmitter of the Crosley Radio Corporation, which will be on the air continuously from now on with the most powerful carrier wave ever transmitted through the ether. President Roosevelt, in a message to Powel Crosley, Jr., said: "I have just pressed the key to formally open Station WLW. It has been a pleasure to do this. And may I take this opportunity to congratulate you and your staff upon the inauguration of this new radio service. I feel certain that WLW will give the people of our country and those of our neighbor nations a service managed and conducted for the greater good of us all." Congratulations, including messages from Professor Albert Einstein and Guglielmo Marconi, were received from all over the United States and from abroad.

DISCUSSION

THE EXPANSION AND CONTRACTION OF CHROMATOPHORES

THE inexactness of the expressions "expansion" and "contraction" as applied to chromatophores has long been recognized and has been clearly emphasized by Sumner and Mast in a recent discussion of reasonable substitutes for these terms.[1]

What happens in an active melanophore, to take a specific example, is that at one extreme its melanin particles are spread throughout its body and its processes and at the other they are massed near its center. The method by which this translocation is accomplished is by no means clear. It is probably due in large part to the passive transportation of the pigment particles by streaming protoplasm or as a result of pressure readjustments in the semi-fluid contents of spaces with contractile walls. But it may also be due

[1] SCIENCE, Nos. 2022, 2028, 2036, 2046.

in part to the movement of the particles themselves, though this general view is not so much in favor at present. Nevertheless, it is certain that these particles exhibit Brownian movement and, were they electrically charged, more or less of their motion might in this sense be ascribed to them directly. Because of the uncertainty of this whole question it seems best to designate the various states of chromatophore pigment in as non-committal terms as possible.

Sumner's suggestion of a chromatosome, melanosome, etc., seems to me artificial, for there is really no such single body of pigment particles as these terms imply. In many melanophores, after most of the melanin particles have been drawn toward the center of the cell, groups of particles may often be seen stranded in the cell processes, showing that no such unity as is suggested in the idea of the chromatosome really exists. I am therefore not inclined to use this term and to speak of the chromatosome as expanding and contracting. I am more in favor of describing the several states of the pigment-cell in terms of its colored particles as one of dispersion of these particles or of concentration of them. In this respect I come nearer in agreement with Mast, who has suggested distribution and aggregation for the corresponding conditions. According to what I have suggested, a chromatophore might then be described as having dispersed or concentrated pigment. If, as seems probable, certain vertebrate chromatophores are provided with double innervation, the two sets of nerve-fibers may be designated as dispersing fibers and concentrating fibers. Neurohumors, if present, may be similarly designated. No writer can dictate a phraseology for another. The terms I suggest are to all intents synonyms of those proposed by Mast, but as every one knows synonyms are often very useful and if they are at the same time a means of avoiding an old difficulty, they may be doubly worth while.

G. H. PARKER

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HARVARD UNIVERSITY

FOLIAR DETERMINATION IN ANGIOSPERMS

THE diversity of foliar structures formed during the development of the shoot in angiosperms represents a problem which has attracted considerable interest from both morphologists and physiologists in the past. The morphological view-point is well illustrated by Potonié,[1] who maintains that such vegetative organs as cotyledons, foliage leaves, cataphylls and bracts are leaf types which have all evolved from a common ancestral assimilatory leaf or "Trophophylle." The floral organs, according to this author, have developed more or less independently from a primitive type of "Sporophylle." In contrast, the physiological view-point, as typified by Klebs,[2] Pfeffer,[3] Jost[4] and Goebel[5] is primarily concerned with the influence of external and internal factors on the differentiation of the foliar anlagen of the shoot. This "causal" outlook has resulted in considerable speculation as to the inherent potentialities of foliar initials. Pfeffer (*l.c.*, p. 143), for example, holds that all foliar primordia are equipotential. Klebs (*l.c.*, pp. 4–6) likewise assumes that leaf primordia are characterized by a wide range of developmental potentialities. Klebs believes that during the development of a primordium many potentialities remain latent in favor of the realization of a dominant or "prospective" potentiality. Often, however, several potentialities may be expressed in varying degrees, resulting in organs which are intermediate in character. Goebel (*l.c.*, pp. 1603–1616), however, attempts to reconcile the morphological and physiological view-points by assuming that the plant forms but one type of leaf initial, *viz.*, the foliage-leaf primordium. Such organs as cataphylls, bracts and the floral structures result, in his view, from the transformation (*Umbildung*) of morphologically identical anlagen.

In the writer's opinion, the problem of foliar determination, as outlined above, raises many fundamental questions which warrant careful examination in the light of modern botanical technique and theory. More exact information is particularly needed as to the cytological and histogenetic processes which accompany the early stages of foliar specialization. In an effort to secure such data, a detailed study has been made of the comparative histogenesis of cataphyll and foliage leaf in *Carya Buckleyi var. arkansana*, Sarg., a species which the writer has already found suitable for morphogenetic analysis.[6] Some of the general results of this investigation seem of sufficient importance to justify a preliminary statement at this time. A detailed report will be published *in extenso* in the near future.

Clear evidence of a profoundly divergent histogenesis between cataphyll and foliage leaf appears when their respective primordia are 90–100 microns in height. This is shown in the cataphyll initial (1) by the rapid vacuolation of many cells in its median

[1] H. Potonié, "Grundlinien der Pflanzen-Morphologie," Jena, 1912.

[2] G. Klebs, *Abhandl. d. Naturforsch. Gesell. Halle*, 25: 1–162, 1903.

[3] W. Pfeffer, "The Physiology of Plants," Vol. 2. Ed. and transl. by A. J. Ewart. Oxford, 1903.

[4] L. Jost, "Pflanzenphysiologie," Bd. 2, Jena, 1923.

[5] K. Goebel, "Organographie der Pflanzen," 3 Teil, Samenpflanzen, Jena, 1932.

[6] A. S. Foster, *Am. Jour. Bot.*, 18: 864–887, 1931; *ibid.*, 19: 75–99, 1932; *ibid.*, 19: 710–728, 1932.

region, and (2) by the rapid acceleration of growth at its margins. The latter process is associated with the extremely rapid formation and vacuolation of irregular groups of genetically related cells and soon results in the typical vaginate form of the cataphyll initial. In contrast, the cells of a young foliage-leaf primordium are more meristematic in staining reaction, and prominent vacuoles are absent from the cytoplasm. The basic histogenetic divergence in such a primordium is evidenced by its early and rapid increase in radial thickness. This type of growth results primarily from the cambial-like activity of a vertical strip of cells beneath the adaxial epidermis and leads to the typical semi-terete form of the foliage-leaf initial. Following this critical period of histogenetic divergence between cataphyll and foliage leaf, rapid morphological and anatomical specialization occurs. Marginal growth continues actively in the scale primordium and is accompanied by the rapid centrifugal and acropetal maturation of a simple type of mesophyll traversed by palmately-branching procambial strands. Conversely, the continued increase in radial thickness of the foliage-leaf initial results in the gradual differentiation of an anatomically complex leaf axis or phyllopodium from the adaxial margins of which two or three pairs of lateral leaflet primordia arise in acropetal succession, the terminal portion of the primordium differentiating into the terminal leaflet.

In conclusion, it must be stated that the early conditioning histogenetic stages in both cataphyll and foliage leaf are preceded by a formative phase in which little or no cytological differences can be detected between their respective primordia. Whether such anlagen are "indifferent" or "determinate" in potentiality remains the central unanswered question in the problem of foliar determination. From this standpoint the problem is not necessarily morphological in appeal. In reality, it challenges, in theory as well as technique, modern genetics and physiology.

ADRIANCE S. FOSTER

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MULTIPLE BIRTHS IN ANTHROPOID APES

SUCH meager information as is available indicates that the frequency of multiple births diminishes in the order primates from the Prosimiae to man. It is reported that twins and triplets may be borne by lemurs, although single births are the rule. The occurrence of twins has been observed also in marmosets and baboons, less certainly in gibbons, and there is high probability that multiple births occasionally occur in many, if not all, of the New and Old World monkeys. For the great apes (orang-outan, chimpanzee and gorilla) we have discovered no published accounts of multiple births. This is not at all surprising in view of the following facts: (1) When a wild female ape carries two infants there ordinarily is no assurance whatever that she bore either, still less both, of them; (2) there have been relatively few anthropoid births in captivity, and of those less than a score have been reliably observed and reported; (3) the frequency of multiple births in man is known to be low, ranging from 1.1 to 1.2 per cent. Our experience in breeding chimpanzees in captivity justifies the surmise that the lack of records of multiple births in captive primates is due primarily to the unfavorableness of nutritional, hygienic and social conditions to normal reproductive process.

Because of the facts which we have presented and our desire to supplement our present information by accumulating all pertinent observations, we wish to report the birth of chimpanzee twins in our laboratories.

Between September 11, 1930, and November 21, 1933, ten seemingly normal births occurred in the chimpanzee colony at the Anthropoid Experiment Station of Yale University, Orange Park, Florida. Of these infants all except one, which died within twenty-four hours after birth, are living at the date of writing. With one exception, the births were single. Fraternal twins, a male and a female, were born on June 26, 1933, after an estimated gestational period of 210 ± 5 days. Although somewhat prematurely born, they were normal and their development has proceeded typically and uneventfully.

The father of the twins has been in these laboratories since September 15, 1925. He was purchased from a ship's officer on arrival in Boston Harbor from Africa. The mother was received as a gift from Mr. Pierre S. Abreu on May 13, 1931. Previously she had been kept for approximately fifteen years in the primate collection of Mrs. Rosalia Abreu in Havana. The estimated age of the father at the date of birth of the twins is eleven years, that of the mother twenty years. She is known to have borne three infants previously. A daughter, born March 24, 1926, now in our colony, is the first chimpanzee of dated birth and positively known parentage and life-history to mature sexually in captivity, so far as we have been able to discover from the pertinent literature. She matured during her eighth year.

The chimpanzee twin birth here recorded is the first to come to our knowledge. True, we have seen chimpanzee infants which were exhibited by showmen as twins. Assertion, however, does not establish fact, and in the only instance in which we were able to make direct inquiry it was promptly admitted, after the nature of our interest had been explained, that the animals were not twins.

We should be very grateful for information about authenticated multiple births in any of the infra-human primates—prosimians, monkeys and anthropoid apes—but especially for chimpanzee. Possibly we may have overlooked some published records, despite diligent search. As we have intimated, it is impossible to take seriously the word of showmen in this connection. Our informants will oblige us greatly by giving specific references to published data and grounds of authentication in case of unpublished observations.

ROBERT M. YERKES

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PERMIAN SHARKS OF WYOMING AND OF EAST GREENLAND

THE Phosphoria formation of Wyoming has two fish-bearing members, the upper of Permian age. This differs from the lower fauna in that three significant new genera are introduced and *Deltodus* and *Crassidonta* are dropped out. One of the new genera was described as *Dolophonodus uncinatus*.[1] This is an unique barbed tooth or spine with no known related genera.

The members of the Danish East Greenland expeditions of 1926–27 and 1929 collected some fish specimens from marine Permian at Cape Stosch. These were described by Nielsen and the results published in 1932.[2] A new genus and species, *Arctacanthus uncinatus*, of Nielsen is so nearly like *Dolophonodus uncinatus* that they may even be conspecific. Nielsen's species is somewhat larger, the striae on the posterior proximal face divide and do not extend to the margin of the base, and the posterior curvature of the crown is greater. Unless the fish elements represented by these specimens are much more constant in their characteristics than are shark teeth, the two are the same species.

The remarkable similarity of these specimens from widely separated localities indicates an exact correlation between the middle portion of the Phosphoria formation and the Martinia limestone, from which Nielsen's specimens were taken. Marine fish are able to migrate rapidly, and a large degree of confidence can be placed upon them in problems of correlation. A comparison of the other fish species of the two faunas shows a similarity in aspect, but not in species:

PHOSPHORIA

Dolophonodus uncinatus
Janassa unguicula
Campodus variabilis
Cladodus occidentalis
Hamatus phosphoriensis
Ancistriodus serratus
Placoid scales
Ctenacanthus mutabilis
C. browni
Edestus (?) sp.

EAST GREENLAND

Arctacanthus uncinatus
Janassa kochi
Agassizodus grønlandicus
Cladodus sp.
Fadenia crenulata
Copodus (?) sp.
Placoid scales
Undeterminable fin-spine

The fish member of the Permo-carboniferous in East Greenland lies immediately beneath the Productus limestones.[3] There is a general resemblance between that fauna[4] and the fauna of the Pustula member of the Phosphoria, in the top of which lies the fish-bearing bed.[5]

There remains an interesting question of priority in regard to the new genus which the two localities have in common. The writer's paper is dated February-March, 1933, and actually came off the press in March. Nielsen's paper is dated 1932, but was not received in this country until the middle of August, 1933.[6] Either paper may have actual priority and the generic name of the other paper becomes a synonym. By a strange coincidence, the specific name is the same in the two papers. If it is desired to distinguish the specimens of the two localities, these of the later paper must be given a new specific name and must be referred to the genus of the prior paper.

Nielsen suggests that the elements in question are the head-spines (frontal claspers) of the male Chimaeroids. The writer can see no basis for this assumption, but would add to his previous suggestion of a possible symphysial position, that there is a possibility that they are rostral teeth of an Euselachian similar to *Onchopristis*.

C. C. BRANSON

BROWN UNIVERSITY

[1] C. C. Branson, "Fish Fauna of the Middle Phosphoria Formation," *Jour. Geology*, xli: 174–183, 1933.

[2] Eigil Nielsen, "Permo-Carboniferous Fishes from East Greenland," *Meddelelser om Grønland*, 86: 3, 1932.

[3] Lauge Koch, "Carboniferous and Triassic Stratigraphy in East Greenland," *Meddelelser om Grønland*, 83: 2, 1931.

[4] H. Frebold, "Das marine Oberkarbon Ostgrönlands; leitende Fauna, Alterstellung, Palaeogeographie," *Meddelelser om Grønland*, 84: 2, 1931.

[5] C. C. Branson, "Paleontology and Stratigraphy of the Phosphoria Formation," University of Missouri Studies, Vol. V, No. 2, 1930.

[6] The chairman of the editorial committee of the Komissionen for videnskabelige Undersøgelser i Grønland has just written me that Nielsen's paper was issued from the press on October 10, 1932. *Dolophonodus* is then a synonym of *Arctacanthus*, and I now refer the Wyoming specimens to *Arctacanthus wyomingensis*, new name.

A VORACIOUS STARFISH

GILBERT W. TUCKER, of Sarasota, Fla., recently sent in to the Biological Survey, Department of Agriculture, a starfish (*Luidia clathrata*) picked up on the beach, with the rays 145 mm long from the center of the disk. It had swallowed a sand-dollar or keyhole urchin (*Mellita quinquiesperforata*) 60 mm in diameter, and apparently had died as a result of the operation.

The sand-dollar has been completely digested, but the rigid test, though cracked and partly broken, still retains its shape, so that the starfish seems to have a large circular disk.

Most starfishes are very voracious, eating almost anything they can capture and swallow, especially mollusks, echinoderms and worms, sometimes of surprising size. Those with extensible stomachs feed on large bivalves, such as oysters and mussels, and also on fish that have been disabled, especially those caught in gill nets. But it is seldom that a starfish permits its voracity to overreach itself.

AUSTIN H. CLARK

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ON THE COURAGE OF SCIENTISTS

IN the current number of SCIENCE (April 27), under the caption, "Disgrace of German Science," "A correspondent" asks the question, "Is there no courage left among the men of science . . .?" Well, at least your courageous correspondent, who I infer is also a scientist and, at least, a resident of this country, while basking in the sunshine of American freedom, nevertheless, one observes, finds it very convenient for himself to hide behind a pseudonym.

Of course it has not been so long ago when scholars and even public officials in this country lost their jobs for saying what they thought was right and signing their names thereto, and many of them no doubt are still kept from advancement and recognition for having done no more than that. But those men then were in the minority. Judging, however, from the many articles printed in our "big" magazine and newspapers (whose profit incidentally derives largely from lavish advertisements) your correspondent, in the game of berating our neighbors overseas and obfuscating their issues, has the majority on his side. But if he, so favorably placed, exhibits such a degree of funk what does he expect from his German colleagues who have been broken and torn by economic, political and social upheavals and cyclones without end these two decades past?

"Ah, Consistency, what a jewel thou art!"

CHARLES D. SNYDER

SCIENTIFIC APPARATUS AND LABORATORY METHODS

ENDOSPORE FORMATION BY BACILLUS SUBTILIS IN A SYNTHETIC MEDIUM

A NUMBER of papers have appeared within recent years dealing with the old question of endospore formation by bacteria, but few of the workers have utilized synthetic media as a tool for the study of their respective problems. The absence of sporulation in synthetic media was noted by Williams,[1] who was unable to secure satisfactory spore yields with *Bacillus subtilis* in several simple media of known chemical composition. Tarr,[2] however, succeeded in obtaining good sporulation by several aerobic spore-forming bacteria after seven days' incubation in a medium containing mineral salts with a low percentage of sucrose and of secondary ammonium phosphate.

The use of a simple synthetic medium in which a high percentage of spores will be produced within a short period of incubation is very desirable, particularly in the study of physiological conditions influencing sporulation. The effect of various ion combinations on sporulation, and on the resistance to adverse environmental conditions of the spores produced, can be much more satisfactorily determined when a relatively simple synthetic medium is used than is the case when a complex organic medium is employed as a base. Also, where synthetic media are used the matter of confirmation of results is greatly simplified.

In an effort to derive a medium of simple formula suitable for the production of appreciable sporulation by *Bacillus subtilis* some sixty combinations of nutrients have been tested. In every medium except one, sporulation has been either absent or much belated. The sole satisfactory medium is of the following composition:

K_2HPO_4	.31 per cent.
KH_2PO_4	.08 " "
$MgSO_4$	.02 " "
KCl	.02 " "
asparagine	.5 " "
$(NH_4)H_2PO_4$	.1 " "
levulose	.5 " "

The salts and amino-acid are adjusted to pH 7.2, sterilized, and the levulose in sterile distilled water solution is added under aseptic conditions.

[1] O. B. Williams, *Jour. Inf. Dis.*, 44: 421–465, 1929.
[2] H. L. A. Tarr, *Jour. Hyg.*, 32: 535–543, 1932.

Bacillus subtilis grows luxuriantly in this medium, there being approximately 200,000,000 cells present per cubic centimeter of the culture after 48 hours' incubation at 37 degrees Centigrade. Sixty to 70 per cent. spores are regularly present within five days (100 per cent. in the pellicle). With Parke-Davis peptone in a 1 per cent. solution as a control, there were 370,000,000 cells, but less than 30 per cent. of these were as spores.

The simplicity of the medium and its capacity for supporting good growth and the rapid production of a high percentage of spores by *B. subtilis* justifies its use in future spore studies with this organism.

J. LEMOYNE ROBERTS

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A SIMPLIFIED TECHNIQUE FOR MOUNTING GROUND BONE SECTIONS TO SHOW AIR-INJECTED LACUNAE AND CANALICULI

THE usual method for such sections is to place a small lump of solid balsam or solidified 10 per cent. gelatine on both slide and cover-glass. Apply enough heat to dissolve the mounting medium, place bone section in liquefied balsam or gelatine, cover and cool rapidly.

Better results are obtained by mounting the dry bone section in either thin or medium thick damar balsam and permitting the balsam to dry in air. No cover-glass should be used. The specimen may be examined while the balsam is drying, for the canaliculi and lacunae become evident immediately and are much more outstanding than specimens in which the bone spaces are filled with débris.

Bone sections so prepared keep indefinitely and are much more satisfactory than those in which heat and cover-glass are necessary. By employing the technique for grinding bone already described in SCIENCE, Vol. 75, No. 1945, "Aloxite as an Abrasive for Grinding Bone Sections for Histology," in conjunction with this simplified mounting technique, an ideal method for preparation of bone sections for classroom use is achieved.

EDMOND J. FARRIS

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SPECIAL ARTICLES

X-RAY DIFFRACTION STUDIES OF THE BUREAU OF STANDARDS RUBBER FRACTIONS

AT the request of Dr. Washburn, a careful preliminary x-ray diffraction study has been completed on various samples of rubber fractions prepared at the Bureau of Standards by the methods already described.[1] The results are so interesting, especially in structural differentiation between the ether-soluble (sol-rubber) and the ether-insoluble (gel-rubber) hydrocarbons, and in producing new data bearing upon the several theories of the structure of whole rubber, that it has seemed desirable to record very briefly some of the more important observations. It will be recalled that native rubber, raw, purified or vulcanized, gives a typical liquid halo or "amorphous" type of diffraction pattern in the unstretched condition, which changes to the characteristic crystal fiber pattern when the rubber specimen is stretched. Upon the basis of these facts several theories of the structure of the rubber hydrocarbon have been proposed: the folded or spiral molecules model; the fringe model (bundles of molecular chains with frayed ends); the flexible chain model and the very familiar two-phase model.

The important new observations on the fractions are as follows: (1) The purified total hydrocarbon behaves on stretching exactly as previously found for rubber.

(2) *The sol-rubber fraction produces no evidence whatever of the characteristic crystal fiber pattern upon stretching even up to 1000 per cent.* The liquid halo is retained under all conditions, but it becomes *broader* in proportion as the percentage of stretch increases (which may be due to decreasing particle size). The same results are observed in the presence or absence of antioxidants.

(3) The gel-rubber fraction produces easily, above 100 per cent. elongation, the crystal fiber pattern, which is quite sharp and intense for 200 per cent. stretch. The liquid halo remains unchanged in width and decreases in intensity as the crystal interferences increase in intensity. When, however, antioxidants are removed and the sheet allowed to stand without vulcanization, it is difficult to find crystal interferences even at 400 per cent. elongation.

(4) The sol-rubber *when vulcanized* begins to show faint evidence of crystal interferences when stretched above 400 per cent., showing that sulfur has produced a profound structural effect. Vulcanization was accomplished by the Peachey (vapor cure) method.

(5) The gel-rubber, vulcanized, gives a fiber pattern at 250 per cent. elongation.

In a detailed paper there will be presented:

Quantitative measurements on 50 or more diffraction films, correlation of these structural observations

[1] Washburn, *Phys. Rev.*, 38, 1790 (1931); Smith, Saylor and Wing, *Bureau of Standards Journal of Research*, 10, 479 (1933).

with physical data such as stress-strain curves, a critical comparison of the theories of rubber hydrocarbon structure in the light of these results, and further x-ray studies of the rubber hydrocarbon crystals actually produced for these fractions at the Bureau of Standards.

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W. H. SMITH

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EFFECTS OF ENDOCRINE EXTRACTS ON THE EARLY DEVELOPMENT OF THE CHICK

THIS study was begun in the fall of 1930 as an attempt to analyze the effect of various endocrine extracts on the morphology of certain organs in the chick embryo and to see if it might be possible to bring about sex reversal. With a greater perfection of technique the studies are taking a decided trend toward sex reversal.

Two methods have been used in this work, the first of which was to inject extract directly into the allantois through the shell. This procedure has several disadvantages: the amount of material injected must be small, a piece of shell must be removed or the injections are not easily made until after about the sixth day of incubation, and lastly, the danger of infection is rather great.

The second method, and the one being used now, is essentially the one described by Hanan, Atwell and Hurd in their researches on the absorption of vital dyes by the allantois. These workers were able to show that in a large percentage of the cases trypan blue could be absorbed by the allantois from the air chamber of the egg as early as the fourth day of incubation. As much as 0.5 cc can be injected at that time. Their technique has been modified very little and it has been found that it is possible to inject twice daily over a period of days. By using the air chamber the amount of extract injected can be regulated better, the danger of infection is reduced to an insignificant factor and injections are made on the fourth day, which is approximately two days before the histological differentiation of the gonads.

A number of endocrine extracts have been used, but most of the experiments have been performed with Emmenin, Whole Pituitary, Antuitrin-S and Theelin. These have been furnished me through the kindness of Eli Lilly and Company and Parke, Davis and Company. The recent work has been limited almost entirely to the use of Antuitrin-S and Theelin. The major difficulty encountered to date has been the regulation of dosage. This obstacle led to a large number of fatalities in the early work, but it has been remedied in the later experiments.

The following results are presented as being indicative, but not with the idea that they represent in any sense completed work. Since it is not possible to analyze the experiments as separate units here, the results are given in summary.

Five hundred and sixty-eight embryos have recently been examined after having been treated with the extracts mentioned above, with the following results: 305 ♀♀; 170 ♂♂; and 93 unknown. The 93 unknown embryos died before sex could be determined. The percentage ratio is 64.3 per cent. females to 35.7 per cent. males. No attempt was made at selection of data. Both the earlier and later experiments were used in calculating these percentages, and as a result the number of unknown cases is high. However, even if all the 93 unknown ones are considered as males, the percentage of females over males would be 7.5 per cent., or 42 embryos.

If, on the other hand, the later experiments be considered as a unit, these having a much lower percentage of unknown cases, we find the following figures: 146 ♀♀; 69 ♂♂; and 15 unknown. If again we consider all the unknown as males, the number of females still exceeds the males by 62, or 27 per cent. Since all the extracts have fractions which affect the female reproductive system, the results appear significant. Also, there have been no experiments in which the ratios have not favored the females. Some male embryos have had asymmetrical testes. Accordingly, questionable gonads have been studied from histological preparations in order to prevent the possibility of interpreting these as ovaries. An interesting thing which has occurred is that the early fatalities, which come after sex can be determined, have been predominately of female embryos, running as high as 83 per cent. in the recent experiments. The experiments with Theelin offer additional evidence against the possibility of all the early deaths being of male embryos. To illustrate, the first three Theelin experiments are examples:

Experiment	I	25 ♀♀; 14 ♂♂;	11 unknown.
Experiment	II	24 ♀♀; 13 ♂♂;	13 unknown.
Experiment	III	34 ♀♀; 14 ♂♂;	2 unknown.

As can be seen from the figures, the dosage was regulated best in Experiment III, and it would appear that the preponderance of females was increased by the addition of members constituting the unknown class in Experiments I and II. The Antuitrin series give similar results.

A large number of eggs have been injected with

salt solution to serve as controls and in these the sex ratio has been 52 per cent. ♀ to 48 per cent. ♂. The work is now being continued, using eggs from a barred, non-barred cross so that sex-linked factors may be used as a check. Additional Leghorn eggs are also being used to increase the data from a statistical point of view.

W. R. BRENEMAN

INDIANA UNIVERSITY
OCTOBER 13, 1933

THE NATIONAL ACADEMY OF SCIENCES. II

Thermal overflows, thallophytes and rock building: WILLIAM ALBERT SETCHELL. Thermal springs are of wide occurrence over the world, and thermal overflows of water charged with calcareous or with siliceous salts are particularly noteworthy because of the presence of thermal thallophytes and their relation to deposits of sinter, both calcareous and siliceous. The thallophytes exhibit their most conspicuous formations and associations in the warmer portions of the overflows, but there are some noteworthy representatives at about the limit of the thermal and the cooler portions of the overflow. The unicellular thallophytes not forming colonies do not need special mention. Those forming colonial aggregates of some size are not associated with rock building. One colorless filamentous species excretes crystalline sulfur in the hottest portions of calcareous overflows, but no lime, while those inhabiting siliceous waters are devoid of any mineral deposit. The filamentous species of the warmer portions of the overflows containing chlorophyll surround themselves with jellies and the gelatinous masses, firmer or softer, may be associated with the laying down both of lime and of silica, but in varying degree. Certain species seem to have no association of this sort. Some species show slight participation, and one species shows a very decided relation to sinter formation, both calcareous and siliceous. In the cooler portions of the overflows, a single noteworthy species occurs in broad bands or patches of a seal-brown color. In calcareous overflows, lime is laid down in crumbly masses, within the layer of the individuals of this species, while in siliceous waters the sinter separates out as glassy tubes about each filament, but within the firmly gelatinous outer coverings. Since deposition of sinter seems to occur, at least in thermal overflows, only in connection with photosynthetic (*i.e.*, green) thallophytes (or Algae) and since only certain of these are thus associated, there seems possible an active (not passive) relation between certain Algae and rock building, as well as a certain specificity as to the species concerned. The various forms assumed by the jellies of these active aggregates affect and control the external forms as well as the internal structure of the sinters laid down.

Quantum relations in photosynthesis with Chlorella: B. M. DUGGAR, J. F. STAUFFER and FARRINGTON DANIELS. Quantitative measurements have been made on the utilization of carbon dioxide under the action of monochromatic light of measured intensity; likewise, by comparison, of polychromatic light. Light from a mercury arc of high intensity was passed through a monochromator or filter and thence through a stirred suspension of Chlorella. The incident and the transmitted light were measured with a thermopile. The change in oxygen and carbon dioxide of the gas passed through the exposure cell was measured with a special burette. Successive determinations were made in the presence and absence of illumination. When the rate of carbon dioxide assimilation was directly proportional to the light intensity, 0.06 of a molecule of carbon dioxide reacted per quantum of light absorbed. This value of the efficiency of the cell is considerably less than heretofore reported by other investigators.

Some problems in cellular pathology as approached through studies both of crown gall and related pathological growths of plants and of cell-stimulating bacteria: A. J. RIKER (introduced by L. R. Jones). A study of several physiological problems involved in cellular pathology and related to atypical and pathological growth are being approached through the use of easily manipulated plant materals. Examinations have been made of certain physiological changes induced in known substances by cell-stimulating bacteria, including *Phytomonas tumefaciens* (Smith and Town) Bergey *et al.* The ability of single-cell cultures to utilize various sources of carbon and nitrogen has been studied. Quantitative determinations have been made of some of the metabolic products from glucose. Changes in hydrogen-ion concentrations have been found to depend on the composition of the substratum. The plant extracts used were turned alkaline. The oxidation-reduction potentials became more negative in a variety of media. However, crown galls of tomatoes were more positive than contiguous uninfected tissue. Causal relations between either the metabolic products or the physical chemical changes following bacterial action and cell-stimulation are difficult to demonstrate because a large number of factors may induce cell proliferation. Two aids in this direction have been found and are being applied to various working hypotheses. (1) Inoculations with crown-gall bacteria on tomato were followed by galls at 28° but not at 30° C., although host and parasite grew well at both temperatures. (2) From a single-cell parent, sister cultures have been secured, one of which has lost its pathogenicity.

The prolonged activity of momentarily stimulated nerves: G. H. PARKER. According to conventional neurophysiology a nerve when severed from its center and momentarily stimulated is supposed to respond by momentary activity, as is well shown in the single twitch of the attached muscle when a severed motor nerve is subjected to a single electric shock. Such momentary activity does not seem to characterize chromatophoral nerves. When such a nerve in the tail of a catfish is cut, its effectors, the melanophores, spread their pigment and a dark band appears over the area of the tail controlled by the cut nerve. This band may persist for as

much as seven days, during which time it gradually subsides and eventually disappears. This lengthy period is believed to be one of continuous activity of the dispersing nerve-fibers, notwithstanding the fact that the stimulus to excitation was the momentary act of transecting them. By appropriate tests it can be shown that the chromatophoral nerves concerned are not inhibitory, are not degenerate and are open to reactivation. The lengthy period of their activity is not due to mere mechanical stimulation of the nerve-fibers at the cut. It is apparently something inherent in the fibers themselves. These fibers are believed on good ground to be autonomic fibers and hence non-medullated. They are concerned with the dispersion of pigment in the melanophores and hence, to use the conventional classification, they belong to the parasympathetic system. These facts may justify their apparently exceptional action, though it must be kept in mind that among medullated fibers those concerned with pain exhibit long-continued activity and that Adrian has shown recently that there is a certain amount of subsequent discharge in severed mammalian nerves. From what has been stated it appears that the dispersing chromatophoral nerves of the catfish can be activated by transection and that this activation may persist for as much as seven days.

An interpretation of the conflicting views as to the life cycle of the Foraminifera: C. A. KOFOID. The researches of Myers have demonstrated on cytological evidence the continuous life cycle of the Foraminifera, involving an alternation of the asexual generation of agamonts in the microspheric tests terminating in multiple fission forming young gamonts of the sexual generation each in a megalospheric test. The megalospheric or sexual generation closes with maturation and a reduction division, forming haploid gametes. The gamonts or megalospheres are enclosed in a fertilization cyst imprisoning the amoeboid, but not flagellate, gametes; resulting zygotes are released from the cysts and grow into the agamonts of the asexual generation in the microspheric shell. There is in this cycle no trace of the flagellate stage. The flagellate stages reported by previous investigators as gametic zoospores have in the past been questioned, even by Lister, because of lack of cytological evidence of their genetic connection with the nuclei of the foraminiferan. The grounds for doubting the validity of the interpretation of these structures as foraminiferan zoospores are: (1) The finding of a typical life cycle with cytological and observational proof of genetic continuity by Myers; (2) the occurrence of so-called zoospores with one, two or three flagella; (3) the report of occurrence of flagellates arising from both the microspheric and megalospheric tests; (4) the wide occurrence of flagellates as parasites in marine invertebrates both in Protozoa and Metazoa. The hypothesis that these so-called gametic zoospores are in reality flagellate parasites rather than gametes seems all the more probable, though still requiring cytological confirmation. The life cycle proven by Myers' researches gives an adequate biological explanation of the occurrence of microspheric and megalospheric tests and of the phenomenon of associated tests in recent and fossil Foraminifera.

The life history of Patellina corrugata, a Foraminifera: EARL H. MYERS (introduced by C. A. Kofoid). The life cycle of the Foraminifera as proposed by Lister (1895) assumed that flagellate organisms seen emerging from the tests of Foraminifera were gametes. Although Lister was hesitant about accepting these conclusions, they were supported by Schaudinn (1903); Winter (1907) and Hofker (1930). No critical cytological evidence concerning the origin of the nuclei and gametogenesis exists in the literature. The account of the life cycle of *Patellina corrugata* Williamson presented in this paper is based on permanent cytological preparations and photographs of living organisms reared in cultures under continuous laboratory control and prolonged observation *in situ*. In this life cycle there is a regular alternation of generations. The asexual or microspheric generation has its origin in a diploid zygote formed by the union of the two haploid isogametes. The sexual or megalospheric generation arises from the asexual microspheric by multiple fission. Beyond the fact that dimorphism in the Foraminifera is due to an alternation of generations, the life history herein outlined has little in common with the ideas advanced by previous workers. There is no evidence of chromidial origin of nuclei, but all nuclei in the entire life cycle are derived solely by mitosis. The haploid gametes are spherical amoebulae fusing to form diploid zygotes. No cytological evidence of a flagellate stage or of any of its associated kinetic structures, such as a rhizoplast, blepharoplast, parabasal or flagella, were observed. In the life cycle of *Patellina corrugata*, the zygote is formed within a fertilization cyst composed of agglutinated débris that encloses the several megalospheric gamonts which have previously united in syzygy. Kinetic activity of the nuclei of the developing microspheric individual falls into two periods. In the first period two post-zygotic divisions give rise to a four-celled somatella. The microspheric proloculum is formed as a lateral lobe during the resting phase between these first two divisions. Usually one, rarely two, of these nuclei degenerate. After a period of vegetative activity the adult microspheric test, consisting of a primordial test and about ten semi-lunar chambers, becomes enveloped in a protecting multiple fission cyst. In the second period a resumption of the kinetic activities of the microspheric nuclei results in two equational divisions to form a twelve-nucleate somatella. After the escape of the somatella from the microspheric test into the multiple fission cyst, a megalospheric test develops around each of the twelve nuclei. Multiple fission results in twelve megalospheric individuals, each with a single nucleus and a test consisting of a spiral chamber of about one and one-half whorls. These megalospheric gamonts associate in groups of two or more in syzygy and give rise to an enveloping fertilization cyst. Syzygy results in the simultaneous activation of the several individuals. The single nucleus within each megalospheric gamont undergoes two progamic divisions before the cytoplasm and contained nuclei escape into the umbilical depression of the respective tests. Each four-celled somatella then divides to form four mononucleate gametocytes. At no time is there a union of endoplasm or nuclei between the several tests. Plasmotomy and the reduction division of these

blobs results in eight times as many spherical amoeboid gametes as there were gamonts involved. Fertilization is accomplished by the union of two haploid gametes to form a diploid zygote, thus completing the life cycle.

Tone quality: C. E. SEASHORE. The concept of tone quality has been analyzed experimentally as a basis for definition and job analysis for further investigation. Tone quality is found to have two components: first, timbre, which depends on the harmonic constitution of the single wave, its absolute pitch and total intensity; and second, sonance, which depends upon change in timbre in a sequence of waves. A complete analysis or measurement of the quality of any sound in nature or art therefore involves the following items: I. Timbre: harmonic composition, single wave. 1. Number of partials. 2. Distribution of partials: region, smoothness, isolation. 3. Relative intensity. 4. Total intensity. 5. Absolute frequency. II. Sonance: sequence of waves. Items 1–5 as above. Change: periodic, progressive or erratic. Such analyses were exhibited for ten representative orchestral instruments, showing the characteristic quality of each instrument and the change of harmonic constitution with change of total intensity and frequency. Applications are made for the improvement of methods of recording, the preservation of primitive music and principles of phonetics.

Transformations in optics: EDWARD KASNER. In this paper all transformations of lineal elements (x, y, z, y′, z′) of space are determined such that every normal congruence of curves shall be converted into a normal congruence. The infinite group obtained is isomorphic with the group of contact transformations in space. The only transformations in the new group which convert curves into curves are the conformal transformations which form a 10-parameter subgroup. The results are of interest in connection with the optics of general isotropic media. It is shown that the only transformations which convert an involution pair of partial equations into an involution pair are contact transformations. An equivalent problem is the transformation of the class of all integrable Monge equations into itself.

Transmutations by artificially accelerated particles: C. C. LAURITSEN and H. R. CRANE (introduced by R. A. Millikan). A description is given of the equipment in use at the California Institute of Technology for work on nuclear problems. The available data on gamma rays and neutrons produced when some light elements are bombarded with fast particles are presented.

The distribution of energies among the positive electrons ejected from some artificially produced radioactive bodies: CARL D. ANDERSON and SETH NEDDERMEYER (introduced by R. A. Milliken). Analysis of the charged particle radiations given off by the artificial radioactive substances produced by Lauritsen and Crane has shown them to be exclusively positive electrons or positrons. The energy distribution among these positrons has been measured in the cosmic ray cloud chamber energy measuring apparatus of the California Institute of Technology. The spectra are continuous and similar to those of the beta rays from natural radioactive bodies.

Cosmic ray energies at very high altitudes: R. A. MILLIKAN, I. S. BOWEN and VICTOR NEHER. From the records of our self-registering instruments carried in airplanes up to 29,000 feet and in balloons up to 62,000 feet (94 per cent. of the way to the top of the atmosphere) we are able to draw certain definite conclusions as to values of the cosmic ray energies throughout the greater part of our atmosphere. These conclusions are presented and their relation to existing cosmic ray theories discussed.

Sodium rhodanate and anesthesia: WILDER D. BANCROFT and JOHN E. RUTZLER, JR. Experiments on man have shown that sodium rhodanate is antagonistic to morphine, alcohol and amytal. Some people have been unable to confirm our findings that a suitable injection of sodium rhodanate will counteract the effect of amytal with rabbits. The failure of those who have tried to confirm these findings has been due to incorrect evaluation of their results because of the variability among rabbits. Rabbits anesthetized with amytal and subsequently treated with sodium rhodanate are found to recover in a longer or shorter time than the controls, depending upon the dose of sodium rhodanate used. Furthermore, it is found that sodium rhodanate markedly lessens the intoxication that is present during the latter stages of the anesthesia. We have just learned that Professor Wolfgang Pauli used sodium thiocyanate nearly thirty years ago successfully to counteract various physiological disturbances in man. He did not study psychoses, morphinism or alcoholism; but his line of reasoning was the same as ours, and he can be said to have confirmed our results long before we thought of getting them.

The neoplastic traits of a mammalian growth due to a filterable virus—the Shope rabbit papilloma: PEYTON ROUS and J. W. BEARD. Efforts to separate causative agents from neoplasms have been successful only in the case of the tumors of fowls. The authors have experimented to learn whether the skin papilloma (Shope) of "cotton-tail" rabbits, which is due to a filterable virus, is an inflammatory or a neoplastic growth. They find that the verrucous form assumed by the papilloma and the slight inflammation at its base are the consequences of its superficial situation. On transplantation to the interior of the host it manifests the characters of a tumor, behaving often like a malignant one. There it develops solely by a multiplication of the transplanted cells; and this would appear to be true also of the skin papilloma, once it is well started. Within the body the growth is nodular and is frequently unencapsulated; it directly replaces the substance of organs; recurs and is readily disseminated in deep wounds; implants itself upon the peritoneal lining; invades blood-vessels; interferes with function; and, growing progressively, induces cachexia and kills the animal. Thus far, however, it has

not metastasized. The proliferating epithelium shows many division figures but no inclusion bodies suggestive of virus infection. The histology is that of an epidermoid carcinoma. The behavior of the papilloma, when protected from injury or bacterial infection, as after transplantation to the interior of the body, is that of a typical neoplasm; but in the circumstances of its natural occurrence, as reported by Shope, it differs significantly from the latter. It is endemic amongst wild rabbits and is frequently multiple; it is referable to a causative agent which can be readily separated from the proliferating tissue; and a single injury of the epithelium is sufficient to enable this agent to act. The occurrence of the growth evidently is conditioned by but few factors, whereas that of the generality of mammalian tumors would appear to be dependent upon many, or upon very special ones. The supposition that the latter are due to an extraneous cause would entail the assumption that this cause is well-nigh ubiquitous but is so greatly conditioned in its action by various factors that its presence can not readily be demonstrated by either the experimental or the statistical method.

Science and conservation: JOHN C. MERRIAM. To be printed in SCIENCE.

The present status of the values of e, h, and e/m: RAYMOND T. BIRGE. A precision value of the electronic charge e may be determined in two different ways. The specific charge e/m may be determined in several different ways. But the Planck constant h can be determined only in connection with e or e/m. There are, in addition, a number of types of experiment that yield a f(e, h, e/m). In every case these three constants occur only as factors, so that each function may be written as $(e)^a \cdot (h)^b \cdot (e/m)^c$, in which the exponents a, b, c are integers, positive or negative or zero. One such f(e, h, e/m) is Bohr's formula for the Rydberg constant, for which the experimental value is known to one part in 10^6. This formula is still believed to be correct, and by its use e/m may be eliminated from any other f(e, h, e/m), thus giving a series of f(e, h). Each of these functions can be written in the form $e = a \cdot h^m$, in which a is an experimentally determined magnitude, and m is found to vary in value from zero to unity. Developing a general idea first suggested by W. N. Bond, we write $e_m \equiv a \cdot h_o^m$, in which h_o is an assumed value of h, and e_m a resulting apparent value of e. This may be transformed, by a Taylor's expansion, to $e_m = e - (e_o \cdot \Delta h/h_o) \cdot m$, in which e_o is an assumed value of e. The plot of e_m against m is thus linear. The intercept gives the true value of e, and from the slope one obtains the true $h = h_o + \Delta h$ (see R. T. Birge, *Phys. Rev.*, 40: 228, 1932). There are at least 14 distinctly different types of experiment, with 9 different corresponding values of m, each of which is capable of giving an accurately determined point on the e_m diagram. Any *two* such points, at different values of m, correspond to a definite value of e and of h. The Rydberg constant formula then gives e/m. If all the experimental data were consistent, the 14 points would lie on some one straight line. Hence the e_m diagram shows at a glance the relative consistency, or lack of consistency, of the experimental data. It is also possible to plot on this diagram, at various values of m, auxiliary scales giving the values of quantities such as the Bohr magneton, the fine-structure constant, etc., directly measured by the several experiments. The e_m diagram is thus transformed into a nomographic chart, from which may be read not only the values of e, h and e/m corresponding to any assumed linear graph, but also the values of these other quantities, such as the Bohr magneton, required in order to make all the data consistent. The chief object of the present paper is to illustrate the remarkable "bird's-eye-view" that this diagram gives of a situation of great intrinsic complexity. In 1929 the writer pointed out an outstanding discrepancy in the various experimental values of e/m. As a result of numerous investigations since then, the discrepancy has disappeared, and three very different methods now yield 1.757×10^7 *em* units. There has, however, now arisen an equally outstanding discrepancy between the wave-lengths (λ_g) of x-rays, measured directly with a grating, and the values (λ_x) deduced from Bragg crystal reflection, assuming a geometrically perfect crystal of calcite, and assuming some value of e ($= e_x$). The Siegbahn system of λ_x corresponds to an assumed $e_x = 4.7740 \times 10^{-10}$ *es* units. The λ_g values require approximately $e_g = 4.805$. The best direct measurement of e (by Millikan) gives 4.768. The author has made extensive recalculations of recent experiments, such as those on refraction of x-rays, diffraction of electrons, etc., introducing the latest theoretical developments, as well as improved auxiliary constants, and each result is shown as a point on an e_m diagram. Two of these points, as well as Eddington's theoretical $1/\alpha = 137$, are fairly consistent with $e_g = 4.805$. One point (σ) requires a value of e much *lower* than 4.768. Two methods (Compton shift and fine structure of hydrogen) do not now give precision results. The remaining points are all fairly consistent with $e = 4.768 \times 10^{-10}$ *es* units and $h = 6.547 \times 10^{-27}$ erg. sec, giving $e/m = 1.7574 \times 10^7$ *em* units, $1/\alpha = 137.41$. Certain alternative assumptions regarding x-ray wave-lengths shift the position of 5 points on the diagram, without, however, improving the consistency, and as long as the uncertainty regarding these wave-lengths remains, the values of e, h, etc., just given can not be said to be at all certain.

(*To be concluded*)

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